system of classification of the vegetable kingdom, an outline of which we have already given to our readers (vol. xviii. p. 646). The author brings to his work a mind trained to great accuracy in the use of terms and in the perception of morphological homologies. Great advantage would ensue by the introduction into vegetable morphology in this country of a similar scientific terminology. A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

American Exploration [1]

North-western Wyoming and Yellowstone Park

DURING a portion of the period 1870-4, the writer was engaged in service as military engineer of the staff of the troops serving in the geographical department of the Platte, U.S.A. This business involved the accumulation of local geographical information for the use of the troops who were constantly in contact with hostile Indians. The most troublesome of these were the Sioux, whose prowess in battle has since been shown to the world in the story of the battle of the Little Big Horn—the Custer massacre.

Within the limits of this department were several dark spots on the map marked "unexplored." One of these was the north-western corner of Wyoming territory—a region of vital interest to geographers, comprising, as it did, the crown of the North American continent. There lay, wrapped in impenetrable mystery, the trackless forest country where, in native lore, the Great Spirit evidenced his eternal anger by spouting great columns of water and smoke into the air far above the highest tree-tops, by filling the air with strange rumbling sounds, and Bad Medicine smells; and by flinging the waters of the great river into the bottomless depths of the Cañon of the Yellow Stone. There lay the Lake Beautiful high on the mountain side, from whose borders the Great Spirit puffed great clouds of smoke. There were the strange mountains that no man had ever entered, and whose existence was only indicated on the best maps by a hazy line of feeble *hachures*. Somewhere in that black and forbidding mass of the Unknown Mountains were hidden the secrets of the sources of the Yellowstone, the largest feeder of the Missouri, as well as those of the Columbia and the Snake. They were literally the "Unknown" Mountains. They had been looked at in awe from a few spots on the west and north, and from the south-east by a few travellers whom they had turned back from the glittering prize just as it seemed within their grasp. They were unknown to the Indians who lived on their border, with the exception of a handfull of outcasts from the Crows and Shoshonees, who, driven from all intercourse with their fellows, were obliged to live in the mountains, of which even they had acquired but a limited and uncertain knowledge. Along their eastern border spread out the hunting-grounds beyond compare of the Sioux, Arrapahoes, Cheyennes, and Crows, from whence no white man or peaceful Indian could ever hope to return unless prepared to cope with fearful odds. The mildest geologist on the planet could not have entered that happy hunting-ground without finding his own—without leaving his bones to whiten in a lonely vale and his scalp to decorate the evening entertainment of some untutored child of nature.

In the winter of 1872-73 General Ord, commanding the department, informed me of his desire that what remained of this dark spot in his field of operations should be cleared up, and, if possible, that a passage-way be discovered between the sources of Yellowstone and Wind Rivers. This would give easy access to the recently-discovered Yellowstone Park region, and very much simplify the question of the shipment of supplies to some of the posts in Montana. This was the sole origin and animus of the expedition.

At that time there had been published concerning the Yellowstone Park region the following:—Hayden's "Geological Report of 1871," Barlow and Heap's "Reconnaissance," and Doane's "Narrative." Of these, Hayden's work was a rapid geological reconnaissance not based upon any topographical work worthy of mention; Barlow and Heap were two officers of engineers who made a military reconnaissance, in which astronomical and topographical instruments were used by trained observers; while Doane, also an officer of the army, simply recounted what he saw. It was also known that Hayden had spent the season of 1872 in the immediate Park region, but that he had not examined the country to the southward and eastward of it. Acting upon this information, and such as had come to me through considerable hard service in the neighbouring country, I decided to carry what explorers call a preliminary triangulation from the surveyed region of the Union Pacific Railroad northward into the Yellowstone Park, there connecting with the work of previous explorers. This route would take me through the region infested by hostile Sioux, thence through the unknown mountains from the eastward into the Park, and thence recrossing somewhere in the neighbourhood of the sources of the Yellowstone. I felt satisfied that, with a thoroughly efficient pack-train, this could be accomplished before the early snows rendered the mountains impassable.

The event proved that if those pack mules had not been handled with the utmost skill by the men in charge of them, and had they not had the agility of squirrels, we should have been turned back into a hornet's nest of redskins.

I had no particular intention of reduplicating anybody's work, but if such happened I am very glad of it. In the cause of science a little duplication and reduplication are things not to be sneered at. Dr. Hayden has been at work this very season reduplicating his own work in the Park and mine too, and I do hope and pray, if there be anything erroneous or incomplete in my work, that he may find and point it out. I am not afraid of truth and right, even though it lay me prone in the dust. It would be a pity indeed if, with the sum of $75,000 and upwards at his disposal, with an outfit that has been the growth of so many years of his own and other people's experience, and with the only dangerous Indians in the whole region completely quiescent and humbled to the dust—it would be a pity indeed if the sum of our knowledge of that wonderful region were not very largely increased and many former errors discovered.

Exploring is at best imperfect work, so far as the survey, which is its foundation feature, is concerned. Observations for longitude with any known portable instruments are painfully erratic unless there be abundant time; angles taken with a light shaky transit in a gale of wind from the summit of one mountain to the most pointed aspects of the summits of others in sight must make some very "holey" triangles; and yet this is the best that has been done or can be done unless there be time and money for a regular survey.

With such an expedition as mine it would have been a sad pity not to give trained scientists an opportunity to gather some of the treasures in our path, and so after careful selection and the advice of one of the most competent scientists in the country (Prof. O. C. Marsh), I took with me some specialist observers. They were excellent hard-working men, and have every reason for being proud of their work. The sum of money placed at my disposal for the work was $8,000.

Prof. Geikie has, I fear, been misled by the one-sided Report of a Congressional Committee.[1] This Report does not afford a fair idea of the issues with which it deals. It conveys the impression that the Engineer Department of the army had been making efforts to absorb the Hayden survey. I was at that time in a position to know that such was not the case.

It may be well to add that both by law and long-continued practice, a portion of the duties of the engineers of the American army comprises public explorations and surveys, and they have always given the greatest possible assistance to specialist observers, who can always do very much more and better work when they have no cares other than those of observation and reflection.

Of Dr. Hayden I would like to say that few men deserve more commendation for successful labour than he. Where others had always failed, he had succeeded in securing fr om Congress

[1] See NATURE, vol. xviii. p. 315.

[1] House Doc. Report 612, 43rd Cong. 1st Session.

annual appropriations of about $75,000. I know him to be an indomitable worker in the field, and well remember the day when his annual arrival in our department was hailed with the greatest interest, and was the signal for every possible act of kindness and assistance from one end of the command to the other.

Prof. Geikie's quotation, that the presence of an armed escort needlessly irritated the hostile Indians, is out of the pale of decent characterisation. In those days army men were of the opinion that no party having less than 100 long-range breech-loading rifles could safely pass into certain portions of the Sioux country, and that minimum-sized parties could just about take care of themselves on the defensive. That was the basis upon which my party was organised. That there was some error in this judgment was shown by the Custer massacre not long after. To the other portion of the quotation, that the geologists of the Interior Department were never molested by Indians, I will state, from personal knowledge, that they have always taken the most precious care not to operate in the neighbourhood of dangerous Indians, a very sensible proceeding for parties without armed escort. Through carelessness and lack of knowledge of the system of guarding camps, they have been stampeded once or twice by thieving Indians who were after plunder, but did not dare to kill anybody. This misfortune has recently befallen them in Yellowstone Park, where the commonest precautions would have made it impossible. Their presence alone, without armed escort, seems to have been "irritating to the Indians."

W. A. JONES

Geological Climate and Geological Time

I HAVE been much interested in Prof. Haughton's communication to NATURE, vol. xviii. p. 266, on the subject of geological climate and geological time. I fully agree with him that geological climates cannot be explained by any change in the position of the poles, even supposing such change possible, and for the reason assigned by him, viz., that we have no palæontological evidence of an arctic climate in any portion of the earth in any geological period previous to the glacial. But I have some objections to make to the data on which he bases his estimates of time, and therefore to his views as to the *cause* of geological climates.

I. He supposes aqueous agencies to commence operation, and therefore the archæan (azoic) era to commence when the earth surface had cooled to 212° F., evidently because, as he thinks, water could not exist as a liquid on the earth's surface at a higher temperature. But the writer forgets that with all the water of the ocean in the air as vapour, and the large quantity of carbonic acid now existing in the form of carbon and the carbonates also in the air, the pressure of the primeval atmosphere must have been many times—perhaps several hundred times—greater than now, and the boiling, or rather precipitating, point of water very much higher than 212°.

II. Again: Even with a surface temperature from internal causes of 212°, the crust of the earth must have been *very thin*, not more than 40–50 ft. (for increased atmospheric pressure, though greatly affecting the boiling-point of water, would not sensibly affect the fusing-point of rocks). Under these conditions—by the law of equilibrium—the inequalities constituting land-surfaces and ocean-bottoms could not possibly exist; the ocean would be universal, and therefore there would be no erosion and sedimentation. Therefore when dry land first appeared and erosive agencies commenced to act at the beginning of the azoic era, the surface temperature from internal causes must have been much less than 212°. For my part I believe that this temperature had already become very small, the surface had become substantially cool, and the crust very thick before land could exist, and the history recorded in stratified rocks could commence.

III. Therefore, though I agree with Prof. Haughton that all the evidence we have indicates uniform climates in early geological times, I would not, like him, attribute this to warm decrease of surface temperature from *internal* causes alone. I would attribute it almost wholly to *external* causes. Among these are:—1. The *constitution of the atmosphere*. The greater amount of carbonic acid and water in the atmosphere would shut in and accumulate the sun's heat on the earth surface according to the principle discovered by Tyndall, and applied to the explanation of geological climates by Sterry Hunt. 2. It is probable that the *heat received from the sun* was much greater then than now; for the sun is now cooling, and has been cooling throughout all geological times much faster than the earth. 3. The idea of Poisson, that in the journey of our system through the stellar universe it may be *now* in a region in which the *heat received from space* is exceptionally small, has been, perhaps, too much neglected in these speculations concerning geological climates. 4. The more *uniform distribution* of this greater surface-temperature from any or all these causes, would of course still farther increase the temperature of *high latitudes*. This more uniform distribution might be due to the position and shape of land masses, or to the less area and the less height of the then lands.

IV. Lastly: I think that a little reflection will show that while it may be allowable to roughly estimate the *relative lengths* of different *eras* by the *relative extreme thickness* of their strata; it will not at all do to estimate the *absolute length of geological times by the extreme thickness of all the strata*. For as the *measuring rod* is not the rate at which sediments are now accumulating at any one place, but the *average rate* over the whole bottom of the sea, so *the thing to be measured* is not the extreme thickness of the strata at any one place, much less the extreme thicknesses of different formations in different places piled one atop the other, but the *average thickness of the strata* over the whole earth surface.

Most of the points brought out here have already been discussed by me in my recently published "Elements of Geology."

JOSEPH LE CONTE

University of California, October 2

The Magnetic Storm of May 14, 1878

I WAS much interested in Mr. Perry's note inserted in NATURE, vol. xviii. p. 617, showing the simultaneity of the magnetic storm of May 14, 1878, in different parts of the earth's surface. As these magnetic disturbances are always accompanied by electric disturbances (earth currents) in telegraph wires, I was anxious to find out what effects were observed upon our wires in England on the same day, viz., May 14. I append an extract from the diary of the Relay Station at Haverfordwest, a very important station on the wires running from London to Valentia, and where very careful observations are made of all interferences with the regularity of the working of the wires:—

May 14.

P.M.

6.40.—First appearance of relays not closing automatic switch well on down side of 202.

7.10.—London finds some difficulty in reading on 199; no cause visible here.

7.40.—Up side of automatic switch on 202 rather unsteady.

9.0. —Variations in London's current on 200.

9.10.—Strong positive deflections (earth currents) on Cork wires.

9.15.—Cork complains of marks missing and running; no doubt the result of deflections.

9.30.—Great difficulty with automatic switches on Cork wires owing to continuous strong positive deflections which tend to opening of switches when battery currents are in opposite directions, and to close them when in same direction. Probably earth-currents influenced them earlier in evening.

9.40.—Deflections diminishing; wires going better.

9.45.—Deflections ceased.

10.0. —All wires going well; weather wet.

10.10.—*Aurora Borealis visible about this time.*

11.25.—Earth currents very strong again on all wires, causing much trouble with automatic switches. Almost full deflection on up side of 201 and 202.

10.40.—Deflection on 202 reversed, and not so strong as before.

10.45.—Full deflection on up side of 202.

10.48.—Deflection on 199 causes up automatic switch to remain depressed.

MIDN.—Earth currents disappearing.

May 15.

A.M.

12.40.—Electric storm seems to have spent itself. Weather fine; clear moonlit sky.